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# NOTES ON THE RELATIONS OF THE MOLLUSCAN FAUNA OF THE PERUVIAN ZOOLOGICAL PROVINCE

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HAVING recently summarized the faunal relations existing between the mollusca of the deep sea, off the western coast of South America, and those of other regions,<sup>1</sup> it has happened that in reporting on a collection of mollusca submitted for examination by the government of Peru, it fell to me to compile a census of the mollusca inhabiting the shallow waters and coasts of the region known as the Peruvian zoological province. Such an enumeration had not been made for something like half a century. The much fuller knowledge of these animals now possessed by scientific students makes the number of species belonging to this region much greater than was formerly supposed, and modifies in consequence the conclusions formerly arrived at.

The littoral fauna has practically nothing in common with that of the abysses. The relations of the two groups of animals to each other, to adjacent faunas, and to the Tertiary fauna, have recently assumed a special interest, from the discussions by von Ihering and others as to the routes of Tertiary migrations.

It was thought therefore that a summary of the results deduced from a study of this faunal list would have a certain general interest not only for malacologists but for the students of historical geology.

The littoral marine molluscan faunas of the west coast of the two Americas, excluding the Arctic and Antarctic faunas properly so-called, were recognized more than

<sup>1</sup> *Bull. Mus. Comp. Zool.*, XLIII, No. 6, pp. 207-211, 1908.

half a century ago in their main outlines by Woodward.<sup>2</sup> They comprise, beginning at the north:

1. *The Oregonian Province*, extending from the limit of floating ice in Bering Sea south to Point Conception, Cal.

2. *The Californian Province*, ranging from Point Conception south to Lower California.

3. *The Panamic Province*, from Lower California including the Gulf of California, south to the Bay of Guayaquil, Ecuador.

4. *The Peruvian Province*, extending from Guayaquil south to the vicinity of the island of Chiloë in southern Chile.

5. *The Magellanic Province*, from Chiloë to the Fuegian Archipelago, and for a short but undetermined distance north on the Argentine coast, on the Atlantic side.

These provinces will eventually be recognized as containing minor divisions, with which, on this occasion, we are not concerned.

The distribution recognized in the term province appears to be directly dependent on the temperature of the surface stratum of the sea, which, in its turn, is distributed by ocean currents. In the case of the Peruvian Province a branch of the eastward-flowing South Pacific current diverges from the main stream and impinges upon the coast of South America in the vicinity of Chiloë Island. Thence it follows the coast northward, until by the north-westerly trend of the Peruvian shores it is diverted, in the vicinity of Point Aguja and Cape Blanco, to the westward, where it continues in the direction of the Galapagos group of islands. This current, known as the Peruvian or Humboldt current, throughout its entire extent maintains a temperature (varying with the season) of from 65° to 70° Fahrenheit. The temperature of the surface off Aguja Point, Peru, in November, was 65° F. The temperature of the water in the Magellanic Province in mid-summer varies from 50° F. in the straits themselves, to 55° F. on the Chilean coast in the vicinity of Valdivia.

<sup>2</sup>“Man. of the Mollusca,” pp. 373-377, 1856.

The surface temperatures of the Peruvian current, as related to those of the Magellanic water, are therefore warmer; and, as compared with the Panamic waters, markedly colder. Precisely such a relation to the coast of North America is held by the southerly branch of the North Pacific current, which reaches the coast near Sitka with a summer temperature of  $65^{\circ}$  to  $68^{\circ}$ . This has diminished in the latitude of San Francisco Bay to  $54^{\circ}$  F., but the current continues until in the vicinity of Point Conception, California, it is diverted off shore in a manner entirely analogous to the fate of the Peruvian current at Point Aguja.

The water of the Panamic Province is less disturbed by currents, receives the full heat of the tropical sun, and, as shown by Professor Alexander Agassiz, emerges from the Gulf of Panama, follows the coast toward Cape San Lorenzo, and is there diverted off shore toward the Galapagos Islands. Trees from the mainland with leaves still adhering to them are occasionally cast upon the shores of the Galapagos, as observed by Professor Agassiz; showing clearly that the current is not only present but has no inconsiderable motion. The temperature of this water near the coast of Ecuador and only a few miles from the limit of the Peruvian current, in November, varied from  $70^{\circ}$  to  $83^{\circ}$  F., and in March and April from  $78^{\circ}$  to  $85^{\circ}$  F. Among the Galapagos Islands the range in April was  $81^{\circ}$  to  $83^{\circ}$  F.

It will be noticed therefore that the currents fully account for the peculiarities of the Galapagos mollusk-fauna, which exhibits large contributions from the Panamic and Peruvian faunas with only a very unimportant tincture of the Indo Pacific in its make-up.

A series of surface temperatures measured in November at right angles to the Peruvian current off Point Aguja, by the U. S. S. *Albatross*, began with a temperature of  $65^{\circ}$  F. close in shore, rose quickly to  $69^{\circ}$  and later to  $70^{\circ}$  in the middle of the current, and declined again to  $69^{\circ}$  F. on its western edge.

The first exploration of the molluscan fauna of the Peruvian Province which was systematically carried on, was that of Hugh Cuming. He was resident for some years at Valparaiso, later dredged and collected vigorously at various points of the Bay of Guayaquil. Tradition has handed down the account that a severe earthquake (referred to by Darwin in the Voyage of the *Beagle*) laid bare a long stretch of coast where the shore mollusks, elevated above their natural situs, were accessible to the collector by the thousand. Mr. Cuming collected largely, and on his return to England these collections gave an opportunity to the systematic naturalists to describe many new Peruvian and Chilian shells. This lasted for a good many years. Broderip, Sowerby, Swainson, Gaskoin, Powys, Deshayes and Reeve worked on these collections during the first half of the nineteenth century. According to Woodward<sup>3</sup> Mr. Cuming's collection embraced 222 species from the coast of Peru, south of Paita, and 172 species from the coast then politically included in Chile. Of these probably half were common to the northern and southern portions of the province. A little later the explorations of Humboldt and Bonpland added a few species; the majority of their collection, it would seem, was not worked up.

M. Alcide D'Orbigny's South American investigations seem to have been, so far as this province is concerned, largely restricted to the Chilean portion of it. He collected 160 species, one half of which were common to Chile and Peru, while only one species was common to Callao and Paita. The inference naturally drawn from this last fact by Woodward and others was that the northern border of the province lay between those two ports. But this conclusion was due to imperfect knowledge, and is completely refuted by later information. At present more than 200 species are known to be common to Paita and Callao.

D'Orbigny's report with its atlas of fine illustrations

<sup>3</sup> Manual, p. 376.

is a classic source for information, relating, however, to South America as a whole rather than to the Peruvian Province.

Collections made by Gay and others, worked up in his monographic *Historia de Chile*, by Hupé, form the third large and well-illustrated contribution to the malacology of the province, chiefly restricted of course to the southern or Chilean portion.

The last important contributor to a knowledge of this fauna in these earlier days was the German naturalist Philippi, who added numerous species and useful illustrations in the *Zeitschrift für Malakozoölogie*, his "Abbildungen," and his "Atacama Reise."

Of course many minor contributors to the work, such as Lesson, Jonas, etc., might be mentioned, but I propose in this hasty sketch to touch only on the most important. The list of Tschudi's collection, ostensibly from Peru, as described by Troschel unfortunately contains numerous exotic Indo Pacific and Panamic species, so that its authority is seriously impaired. More recently the researches of Ludwig Plate, the Princess of Bavaria and others, have added essentially to our knowledge.

In considering the distribution of species along the coast of the province it should not be forgotten that the collections have not been made with equal thoroughness on different parts of the coast. The ports of Guayaquil, Païta, Callao and Valparaiso have naturally been much more thoroughly explored than any of the rest, and the careful collecting which would obtain the smaller species is not recorded to have been done at all, anywhere.

Dredging also is practicable with difficulty, except in the sheltered harbors which occur so rarely on this coast, or by the aid of a large steamer which could be had only under Government auspices on account of the great expense involved.

The small lots of material derived from the mud which came up on the anchor of the *Albatross* at one or two points, show that proper exploration will certainly reveal

the presence of many small species new or extralimital which are at present unknown. In determining what species should be included in the list I have depended somewhat upon the known characteristics, as regards distribution, of the groups to which the species belong. For instance, if I found a species reported from Guayaquil and belonging to a widely distributed group such as the Pholadidæ, though not actually reported from a Peruvian locality, I have not hesitated to include it, knowing that in all probability it will be found on more thorough search in Peruvian territory. There can be little doubt that a large number of the more mobile of the Panamic species reaching the Bay of Guayaquil will be found to have extended their range more or less within the northern border of the Peruvian Province; just as a certain number of the characteristic Magellanic species have traveled beyond their strict limits and mingle with the southern members of the Peruvian fauna. Species properly belonging to the Panamic Province and not reported as far south as Guayaquil or the Galapagos Islands, have been omitted from the list.

It will be observed that the list contains only a few minute shells. Doubtless these exist, and will be found when carefully sought for, but, as previously indicated, the majority of collectors seem to have confined their attention to the more conspicuous species.

I have included a certain number of pelagic forms, cephalopods, pteropods and nudibranchs, which are not strictly littoral, but are found occasionally thrown on the beaches or are captured within a short distance of the shore.

In any first census of this kind, some species will be included which later investigation will exclude. I have rejected a number of Tschudi's species as obviously exotic, but a small number remain which are doubtful, and which are indicated as needing confirmation. I have also omitted a few names which seemed to be almost certainly due to misidentification or to a confusion between such

localities as Arica and Africa. "Lumping" closely related species, such as some of the Siphonarias, has led certain authors to include purely Atlantic forms with their Pacific analogues under one name. So far as time, and the access to specimens, permitted I have tried to disentangle such cases and use only the name definitely belonging to the Pacific form. In making her dredgings the U. S. Fish Commission steamer *Albatross* seems to have avoided shallow water; and in the case of Dentalium, which has a wide range in depth, I have included a few species actually dredged beyond the 100 fathom line, but which will in all probability be found within it when sought for. No other deep-water species, however, has been admitted. An account of them will be found in my *Albatross* Report of 1908. In scanning the list those unfamiliar with the repetition of names so prevalent in Spanish geographical nomenclature will need to remember that there is a Tumbes in Chile as well as in Peru, and be on the look out for analogous cases. Species of Auriculidæ which are exclusively littoral, although pulmonate, have been included, also the salt-water Cyrenas, my aim being to include all species which are to be found along the shores of the province on the beaches and in the adjacent waters of the sea. Whatever deductions from the list may be necessary hereafter, I am convinced that they will be more than made up for by future additions from the ranks of the minuter species.

It is probable, though not by any means certain, that when we eliminate the overflow from the Panamic and Magellanic Provinces, the remaining fauna on this long stretch of coast may be susceptible of division into sub-faunas, but it is too early to speculate about this possible feature of the distribution.

I have indicated in the preceding remark, the nature of the reservations which must be made in discussing the statistics of our present census of the Peruvian Fauna, and subject to those reservations we may now proceed to consider the figures.



The total number of species appears to be 869, of which 64 are pelagic and may be omitted from consideration in the matter of distribution, leaving 805. Taking the present political limits of the two countries as a starting point, we find seventy-one species reported from Peru exclusively, and one hundred and three restricted to Chile. But, as political and biologic boundaries rarely have anything in common, these data are not especially significant. We have 174 species restricted to Peru or Chile and 141 common to Peru and Chile, making 315 species proper to the Province itself. In addition to these we have 253 species common to the Panamic Province and to Peru, and 239 species of the Panamic Province which are known to reach the northern border of the Peruvian Province at or near Cape Blanco, many of which will doubtless be found to have a more extended southerly range. In addition to these there are 25 species whose range extends from Upper California south to Peru or even to Valparaiso.

At the southern extreme of the Peruvian Province it receives 41 recruits from the Magellanic Province, few of which range north of Valparaiso. Of the whole 805 species enumerated which are not pelagic, only 24 are known from the West Indies or Atlantic Ocean, most of which are Pholads, borers, or limpets; forms peculiarly liable to transportation long distances on ships or floating timber. The only species which can be regarded as also Indo-Pacific, are even fewer in number and to be included in the same category.

Eliminating all the pelagic species and all the Panamic species not shown to be now actually domiciled within the limits of the Peruvian Province, we have a population for and province of 566 species of littoral marine mollusks.

In Bulletin 84, of the U. S. Geological Survey, pages 25-28, 1892, I have shown that the average population for a warm temperate area (when the temperature ranges from 60° to 70° F.) is about 500 species of shell-bearing mollusks. Adding the species of nudibranchs, naked

tectibranchs and littoral cephalopods enumerated in our list, it would seem that the average is pretty well maintained in the case of the Peruvian Province.

Dismissing the minuter species from consideration as insufficiently known, the more striking characteristics of the Peruvian fauna may be summed up as follows:

1. There is an unusual proportion of the species which are black or blackish or of a lurid tint. This feature of the fauna has attracted attention from all who have studied it, and has been discussed by von Martens. It is particularly marked among the zoophagous groups.

2. The fauna is notable for its Fissurellidæ and Acmaeidæ, its trochids of the genus *Tegula*, its numerous and peculiar chitons, its numerous cancellarias, the development of Calyptræidæ, of species of Arcidæ and of *Thais*, *Chione*, *Semele*, *Petricola*, *Mulinia*, all represented by numerous species.

3. The deficiencies in the fauna are as marked as the redundancies. There are notably few pectens or *Lucinas*, and the Tellinidæ are poorly represented. *Acteon*, the smaller tectibranchs, *Conus*, the Turritidæ especially, the Marginellidæ, *Fusus* and its allies, *Epitonium* (*Scala*) and the Pyramidellidæ are all very poorly represented. *Calliostoma* and *Margarita*, *Haliotis* and *Pleurotomaria* are absent or barely represented.

The notion that the mournful colors of so many of the species might be correlated with the huge beds of kelp characteristic of these shores, seems to be negatived by the fact that in California similar kelp-beds afford a shelter to some of the most brightly colored Trochidæ, etc., and that, as I am informed by Mr. Coker, red and green seaweeds are abundant on the rocks below low-water mark, on a large part of the coast of Peru, and presumably also of Chile. This and a number of other problems await the investigators of the future.

Lastly, a survey of the characteristic groups of which the fauna is largely made up leads to the conclusion that the fauna is chiefly of southern origin. In spite of the

fact that many species are common to the Panamic fauna and a relatively small number to the Magellanic fauna, the more conspicuous types, like the blackish species of *Tegula*, have a Magellanic rather than a tropical character. This particular group has extended its range to Alaska on the north, and Japan on the northwest, but its metropolis is in southern Chile. The type represented by the various species of *Thais* and *Acanthina* has traveled the same road, and so has the *Protothaca* group of *Veneridæ*.

If we may accept as the original metropolis of a special type of mollusk that region where it is developed in the greatest number and variety of species and perhaps also with the most extreme limits of size and ornamentation, we shall have for example *Buccinum* and *Chrysodomus* focused in the boreal Pacific region; certain types of *Thais* and *Acanthina* in the region of southern Chile. Cook has called attention to the relation between *Thais lapillus* and the Oregonian *T. lamellosa*, and other species in the tropics of the Panamic and Antillean region; but viewed from an eastern Pacific standpoint the relatively few Atlantic forms may easily have originated in the Pacific where their existing representatives show a much more luxuriant development. There is only one *Thais* of the nucella type in the north Atlantic, but the north Pacific has five or six. It is very remarkable that in the Peruvian Province we have not a single distinctively old-world type of Mollusk. Those which seem to be such are really cosmopolitan types more familiar to us from old-world localities, perhaps, but not necessarily of old-world origin.